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Lobelia gloria-montis

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Host Range Evaluation of *Septoria hodgesii* as a Biocontrol Agent for Fayatree

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Myrica faya (Myricaceae), commonly referred to in Hawaii as firetree, fayatree, or simply faya, is native to the Macaronesian archipelagos of the Azores, Madeira, and Canary Islands in the North Atlantic (Whiteaker and Gardner, 1992). This small to medium evergreen tree was introduced to Hawaii in the late 1800s by Portuguese immigrants, presumably as an ornamental (Lutzow-Felling *et al.*, 1995). In the early 1900s faya was planted along with other alien species in reforestation programs (Skolmen, 1979), until its weedy habit and aggressiveness became evident (Fosberg, 1937). Faya is currently a high priority management problem in and around Hawaii Volcanoes National Park, but it also occurs on Maui, Lanai, Oahu, and Kauai at mid to high elevations (600–1,900 m) (Whiteaker and Gardner, 1992). Faya was classified a noxious weed in 1992 by the Hawaii Department of Agriculture (DOA) (Hawaii Department of Agriculture, 1992).

Since the time its invasive nature became evident, extensive efforts have been devoted toward the control of faya through mechanical, chemical, and biocontrol approaches. These efforts have been summarized by Lutzow-Felling *et al.* (1995). Following the standard

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approach for a "classical biocontrol" program, most efforts toward the biocontrol of faya have involved searching in its native habitat for potential biocontrol agents occurring on faya itself, including insects and disease organisms. However, because *Myrica* is a homogeneous and well-defined genus, it is possible that natural enemies of other species of *Myrica* may be useful as biocontrol agents of faya (Krauss, 1964).

A leaf spotting fungus, usually referred to as *Septoria myricae* but recently redescribed as *S. hodgesii* (Gardner, 1999), occurs on waxmyrtle (*M. cerifera*) in the southeastern U. S. Under favorable environmental conditions, this fungus causes leaf spots leading to defoliation in commercial nurseries and ornamental plantings of this shrub. In 1988, faya seedlings from Hawaii were established in a greenhouse at North Carolina State University and inoculated with *S. hodgesii* (= *S. myricae*) (Gardner, unpublished). The resulting leaf spots showed faya, as well as waxmyrtle, to be susceptible to this pathogen. Following completion of the Hawaii Department of Agriculture's (DOA) plant pathogen containment laboratory in Honolulu, host range testing of the pathogen was undertaken at that facility.

Faya has no close relatives in Hawaii. Other than waxmyrtle, which itself has been introduced but has limited distribution, Hawaii has no members of either the family Myricaceae or the order Myricales (Wagner *et al.*, 1990). From a phyllogenetic standpoint, the most closely related families to the Myricaceae are the Juglandaceae and the Fagaceae (Takhtajan, 1969; Cronquist, 1978.) Of these, neither is represented in Hawaii's native or naturalized, nonindigenous flora (Wagner *et al.*, 1990).

In the absence of close relatives to be tested, we selected woody plant species representing a diversity of important components of the native ecosystems into which faya is encroaching. In addition, as an economically important woody species, six widely planted varieties of macadamia nut were selected for testing. In total, we tested 21 species, representing 20 families and 17 orders (Table 1)

Seedlings, approximately 20 cm tall, of most of the above plants were collected from the field within and in the vicinity of Hawaii Volcanoes National Park and transplanted in the DOA quarantine greenhouse. We obtained plants of the varieties of macadamia to be tested from the Mauna Loa Macadamia Nut Corporation, Keaau.

Table 1. The species, families and orders of plants tested for susceptibility to *Septoria hodgesii*.

Order/Family	Species
Apiales	
Araliaceae	*Cheirodendron trigynum*
Asterales	
Asteraceae	*Dubautia ciliolata*
Campanulales	
Goodeniaceae	*Scaevola kilaueae*
Caryophyllales	
Nyctaginaceae	*Pisonia brunoniana*
Celastrales	
Aquifoliaceae	*Ilex anomala*
Celastraceae	*Perotettia sandwicensis*
Ericales	
Epacridaceae	*Styphelia tameiameiae*
Ericaceae	*Vaccinium reticulatum*
Fabales	
Fabaceae	*Acacia koa*
	Sophora chrysophylla
Gentianales	
Apocynaceae	*Alyxia oliviformis*
Lamiales	
Lamiaceae	*Stenogyne calaminthoides*
Liliales	
Liliaceae	*Cordyline fruticosa*
Myrtales	
Myrtaceae	*Metrosideros polymorpha*
Thymelaeaceae	*Wikstroemia phillyreifolia*
Primulales	
Myrsinaceae	*Myrsine lessertiana*
Proteales	
Proteaceae	*Macadamia integrifolia*
Rosales	
Rosaceae	*Osteomeles anthyllidifolia*
Rubiales	
Rubiaceae	*Coprosma ernodeoides*
Sapindales	
Sapindaceae	*Dodonaea viscosa*
Urticales	
Urticaceae	*Pipturus albidus*

We cultured the fungus on artificial medium and made spore suspensions that were adjusted to approximately 1 x 10^6 spores per milliliter. For inoculation, we sprayed plants with a spore suspension in a solution of 2% sucrose and 0.5%

gelatin (Trujillo *et al.*, 1994). Groups of four of each of the above test plants, and two faya plants as positive controls, were inoculated. Following inoculation, we observed inoculated plants for 6 weeks for development of leaf spots or other symptoms.

Leaf spots became visible on all of the faya controls 10–14 days following inoculation. After 6 weeks, the lesions had coalesced on heavily infected leaves, and defoliation occurred. We examined these leaves microscopically to confirm the presence of the fungus, and then reisolated it in pure culture. In contrast, none of the other inoculated plants developed leaf spots. After obtaining these results, we repeated the entire test with the same results.

These results suggest that *Septoria hodgesii* is restricted in host range to *Myrica* spp., and would therefore be acceptable as a biocontrol agent from the standpoint of safety for field release. The question remains, however, whether it is as effective at causing lesions that lead to defoliation in the field as under the ideal conditions of the quarantine greenhouse. Infection of waxmyrtle in North Carolina leading to leaf drop is usually associated with moisture on the leaves in nurseries resulting from overhead irrigation (C. Hodges, personal communication). The humidity in the DOA quarantine facility where the host range tests were conducted was kept high by covering newly inoculated leaves with plastic bags, or by maintaining inoculated plants in plexiglass chambers. Furthermore, the sucrose and gelatin supplementing the inoculum was intended to give the fungus a favorable medium from which to establish infection. Since the natural conditions of the field may not always provide ideal moisture conditions, and do not include inoculum supplements, the actual usefulness of *S. hodgesii* as a biocontrol agent must be determined by its activity under natural field conditions.

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Growing Native
A Regular Feature on Native Plant Horticulture

Notes on Growing the Native Hawaiian Flora

John K. Obata

This is an attempt to quantify some of the propagation techniques that have been ongoing since my first article on germinating the native Hawaiian flora appeared in the *Newsletter of the Hawaiian Botanical Society* in June of 1967 (VI:3).

In reviewing the 1967 article, it was noted that our germination techniques have not been altered significantly. In reality, the introductory phase of the article reflected what we generally are doing today. Unfortunately, we have not progressed much beyond what was recommended then. Perhaps it was all that was needed. Today we generally still use a well draining, semi-artificial medium which affords adequate air movement in the compost. This was suggested in 19678 and this option still applies today. Moisture application still varied with the needs of each species, and this phase has not been altered. Fungicides were heavily in use then, and this option is still pursued by many growers.

Following the 1967 article, a series of other articles chronicled many of the early germination and growing attempts. Unfortunately, many of the statements were heavily edited by the then editor. As I recall, even my original conclusion was severely altered. Thus, some of the original written portion may have had a different connotation from what was originally intended. Fortunately, the original 1967 article (VI:3) was not altered by another editor.

But our focus is growing the native Hawaiian flora. And some of the results obtained today may be quite contrary from what was gotten some thirty to forty years ago. Some results reported as successful in the past cannot be duplicated today. Growing techniques may have been altered slightly with newer growing innovations, but this drastically has not impacted today's cultural techniques. Presently we are faced with a strange dilemma which also plagued us infrequently from the beginning. A plant producing viable seeds from year to year suddenly ceases to bear viable seeds for a season of two. In this phenomenon, the seeds do not display any outward signs of abnormality. And the supposed pollinator was still present. This phenomenon was noted among cultivated as well as those natives growing naturally. A lot of speculations have gone into this phenomenon without any viable explanation. Perhaps this phenomenon will always plague the growing of native flora. We also did note that first year seed bearers or your parent plants, though vigorous growers, often produced little or no viable seeds. More often distressed or aged, dying plants yielded the best viable seeds.

In most instances, today's success rates generally are better than those attained some thirty to forty years ago. This generally may be attributable to more refined techniques. And along the way, we learned how to collect seeds in season at their proper stages and made some minor modifications in our germinating techniques and potting medium. These modifications, though few, played a major role in today's success rates. On the negative side, we also learned that some genera and species defied our many germinating attempts. Failure even extended to the clonal level. And failure was a common denominator in the early years of native plant propagation.

One strange seed behavior seemed to defy logic. When seeds were planted from late summer through early fall, germination in some species did not occur until the onset of the rainy season. And seeds from the same plants germinated with ease in other seasons. The coming of the rainy season

seemed to behave like a biological clock. Some seeds even did not germinate for six months ore even well beyond a year. Strangely, in some years this behavior did not express itself under similar conditions with the same parent plant.

Today our growing media have been modified to adapt to specific needs. As the growing media gradually shifted from natural to artificial and commercial mixes, success rates improved. Soil collected *in situ* and used as a potting medium proved to be a disaster even as we vainly tried to make modifications to it. Along the way, fungicides and sometimes bactericides were used to prevent sensitive seedlings from wilting. Sensitive species as *Joinvillea ascendens* required a steady diet of fungicides.

Today's general potting mix evolved through a series of trial and error procedures even though their ingredients were rather similar. Eventually it involved mixing equal parts of vermiculite, perlite, and peat. A simpler home formulation would be to mix two parts commercial potting mix and one part perlite. For a wetter mix, three parts commercial mix to one part perlite should suffice. A drier mix could be a one to one ratio of potting mix and perlite. Generally, soil should not be added to the potting mix even though it came from the natural habitat of the plant being grown. Some have introduced a little soil to their artificial mix with soils from the plant's natural habitat in the hope of enriching the medium with its natural mycorrhiza. Some positive results have been noted, but so far complete success has eluded this procedure as perhaps soil borne pathogens or poor cultural procedures may have been the problem. And sterilization of pure soil as a potting medium left much to be desired. This medium generally lacked aeration. Pure soil medium tended to cake into an almost impervious mix with the passage of time.

Many of our native flora thrive with excessive fertilizing. Native ferns generally react negatively to fertilizers under cultivation especially under excessive sunlight. Negative behavior was noted even with foliar type chemical fertilizers. For the native flowering plants, organic type fertilizers generally have posed no problem even used in excess. Commercial chemical fertilizers (nitrates and phosphates) also are effective, but may pose some problems in a pot culture when used in excess. It will express itself especially when pot bound plants are inadvertently left to temporarily "dry out" for a few days. A reverse type osmosis will produce leaf wilting. This type of dehydration usually is fatal to seedlings and even to mature potted plants. Not many plants have overcome this lax.

Some advocate the use of volcano cinders. It is a "sterile" type medium that provides abundant drainage and air movement in the medium. It is an ideal potting mix for natives with few negatives. When transplanting natives, one should exercise caution so as not to disturb their delicate root system. Cinder type media tend to move excessively during transplanting sessions and often may set back a plant beyond recovery when their delicate young roots are damaged during transplanting. Also with cinders, its many "pores" have a tendency to accumulate chemical salts from fertilizers (nitrates and phosphates) beyond acceptable levels on a long term basis.

Generally most natives growing naturally below 1200 m (4000 feet) elevation seem best adapted for pot and ground culture in lowland urban Honolulu culture. Natives seem to flourish in their native habitats when they are free of deleterious organisms. Those that have been raised in similar climatic conditions on the continent surprisingly have adapted better than in Hawaii. They lack the deleterious organisms that the natives are constantly subjected to in Hawaii. Some degree of success have been noted with ground planted natives in the lowland, but long term success have eluded much of the plantings so far. Some encouraging signs are beginning to surface with some of the more hardy species. Some failures can be attributed to the lack of horticultural know how by the grower, but often common sense and a suitable location may be the underlying problem.

Generally, a fairly well drained substrate is a necessity to artificially grow Hawaiian endemics. Most xeric (dryland) natives generally seem to adapt well to lowland conditions. Strangely dryland forms from extremely sun-exposed areas have difficulty tolerating excessive amounts of sunlight for a whole day in lowland, urban cultivation. They may be able to tolerate full sunlight for part of the day, but require partial shade during several hours of the day. If they are not exposed to full sunlight during the midday hours, they should adapt well to lowland cultivation. Cool evening temperature also

enhance growth in lowland culture. Until natives become established and acclimated to ground planting, watering and fertilizing cannot be neglected. For the first month or two after urban ground planting, watering cannot be neglected!

Growing plants from wild collected seeds pose a myriad of problems from time to time. Technology is not fully refined at this stage. Success rates are quite variable. The problems are legion. We are dealing with many diverse families with equally diverse requirements. Success with a few species have been well documented. But problems are not family, genus, or species peculiar, but often clonally peculiar. Often in the past, successful techniques were fabricated by non-horticultural individuals. Strangely, few if any of the professional horticulturists have been credited with making significant break-throughs. They have the resources and should be directed to do their research in this direction.

An aside can be interjected here. In the early 1960's, a batch of *naio* (*Myoporum sandiwcense*) seeds were collected from Kaluaa Gulch in the Honouliuli Forest Reserve on O'ahu and later the seeds were germinated. From the some twenty seedlings, a "desirable" form was selected and seeds from it were planted. Seedlings were widely distributed on O'ahu. Offspring from this clone all seemingly attained a "bushy" hemispheric shape and reaching a height of about two meters (seven feet). Its original wild parent plant was an erect plant reaching a height nearly nine meters (30 feet). And if one sees a hemispheric shaped form cultivated on O'ahu, it mostly likely came from this selection process. Aesthetically, it may have been a success, but these offspring lost their natural ancestral stature. The aesthetics of this type of selective breeding can be argued.

However, seed collected propagation of Hawaiian native flora had been systematically hampered by regulations emanating from the office of the past state botanist. Some of these regulations in the past seemed to have negated efforts of botanic gardens and the horticultural industry to popularize our native flora. In the past, growing of the native flora was highly discouraged through administrative directives from this office. With most restrictions lifted today, it is hoped a new dawn of native plant propagation will be stimulated.

Recently, after much input from the botanical community, nursery industry, and the interested public, these unwieldy regulations have been relaxed. Native plants now can be purchased from legitimate sources and the growing of our native plants by individuals in home gardens no longer will be hindered by state regulations. Seed collecting in state lands still is regulated by a permit system. The permit system has its faults as many collectors will encounter seeds that are not listed on the permit designed for the day. Much of the desirable type seed collecting and encounters are random occurrences. And as such the permit system does not cover this aspect. Perhaps a general type permit should be instituted for these individuals to collect a small handful for seeds from these seldom encountered situations. It is imperative that this type of permit be instituted as these individuals are usually the ones who have been the major source of preserving many of our rare and endangered species to date. And most of these seed collections revert to botanical gardens. Interestingly, many natives grown today are from seeds and cuttings collected on private lands and some of the state regulations do not apply to them.

With tissue culture techniques showing some promise, we seem to have another tool for preservation. However, this technique is still in its infancy and hopefully some breakthroughs can be attained so that all natives can be reproduced in quantity without depleting our natural sources. This procedure may reduce wanton collection to the minimum.

As a footnote, those states that have encouraged the growing of their rare and endangered native species by the general public have made tremendous strides in preservation besides promoting public relations. As a result, some of their endangered species have recovered so drastically through general cultivation that some are being considered for delisting. And isn't one of the primary goals of the Endangered Species Act an attempt to delist instead of enlist species? Hopefully Hawai'i will be able to emulate these states in being able to popularize the culture of its native flora over all the alien flora that dominate our landscape.

It is difficult to convince the nursery industry to grow our native flora as many of our native flora require an inordinate amount of care to cultivate. Often availability of seeds or seedlings is limited. Landscape wise, the industry has extensively

utilized *akia* (*Wikstroemia uva-ursi*, an native of Kaua'i) and *naupaka* (*Scaevola sericea*), as they are easy to propagate and readily available. Some native species have been sporadically used and no major trend to grow other native species on the large scale basis is visible even though state regulations mandate their usage in state projects. Even our native *loulu* palm (*Pritchardia* sp.) has been used extensively in the landscape trade, but it often is substituted by two alien sout Pacific pritchardia's (*P. pacifica* and *P. thurstonii*). Unfortunately, some pseudo-Hawaiian flora have masqueraded as natives in the nursery trade. These substitutions are more through ignorance than an intent to defraud. Several forms of *'o'hia lehua* (*Metrosideros*) from New Zealand and the south Pacific region are being sold in Honolulu garden shops as authentic native *'o'hia lehua* species. These forms seem rather popular as they are easier to cultivate than our native counterparts and are relatively free of insect pests. Interestingly, many of our cultivated native *'o'hia lehua* on O'ahu come from Big Island sources. Perhaps an embargo on importing the same species of natives from other islands of the Hawaiian chain should be instituted to insure the purity of the gene pool of each island. The rational used by the recently retired state botanist to impede or restrict seed collecting by the nursery interests and native plant growing enthusiasts was that they will plunder the few remaining rarer plants in the wild is quite an idyllic rationalization. Simply put, the horticultural industry lacks the time nor the know-how to be involved in massive plant and seed collection endeavors. Most generally do not know the whereabouts of these plants in the wild let alone know what they are. The industry generally is interested in plants that are available in volume and those that have fast turn over potentials. They are also interested in plant that are easy to cultivate and adapt well to general ground planting and pot culture. Most of our natives do not readily fit into these criteria.

Interestingly, federal regulations do not place any restrictions on growing even endangered plants. Their regulations restrict the transport of endangered species or seeds transported beyond state lines and collecting on federal lands. And yet, the state botanist tried to enforce regulations that prohibited the growing of plants that originated from private and federal lands and even plants grown from seeds of cultivated stock.

But our interest is growing the natives. And they are not without their natural deterrents. Often insects play a major destructive roll. Some of the major players in cultivation today are the ants, aphids, black twig borer (*Xylosandrus compactus*), and the Chinese rose beetle (*Adoretus sinicus*). Ants themselves are not the destructive force, but they are responsible for farming a wooly type mealy bug (identity unclear) which destroy as they suck the sap from many of the smaller native species till they expire. The black twig borer destroys many natives as well as alien flora as their adult and larval stages vigorously bore through twigs and young branches. Usually this activity results in the demise of the branch or even the entire plant. Many species of natives have been distressed,become rare, or even face extinction because of these activities. It is perhaps the most destructive of the insect pests. Interestingly, robust plants are free of its boring activities. Presently no deterrent or parasite is available.

The common Chinese rose beetle often is known to defoliate many of the native flora in cultivation. Simply put, our native flora seem to be preferred by alien chewing insets over the alien flora. Explanations have been advanced, but none have been substantiated with accompanying data.

If some insects seem to be the consummate destructive force of our native flora, ground golden nematode worms also exact a heavy toll by attacking the root systems of the more sensitive species. Its subterranean microscopic nature does not help in its detection. Where natives about, their destructive force must be reconciled. Unfortunately, the use of nemacides are highly restricted to the general public. Sometimes a natural deterrent as the garden marigold (*Tagites* sp.) may be planted with the natives to act as a natural nemacide. Unfortunately, the newer hybrid strains of marigolds do not seem to be an effective natural nemacide. Sometimes the use of agricultural lime (calcium sulfate) may act as a nematode deterrent. The red spider mite leaves an indelible mark of destruction in various scared tissues on leaves, flowers and fruits of the native flora.

Many alien slugs exact untold damage on seedlings and young plants. Where present today, they seem to be one of the major players in the

destruction of our native flora as they are major consumers of seedlings. One fortunate note: these slugs generally have not penetrated into the higher elevations (above 1100 m/3600 feet) and in those areas the native flora still seems to flourish today. Of the larger slugs, presently three of the have impacted the natives in the wild and in cultivation. They are the brown slug (*Vaginulis plebius*), two lined slug (*Veronica cubensis*) and the black slug (*Veronicella leydigi*). With the increase in recent years of the brown slug (tan colored one) and the two lined brown slug in urban areas, their destructive force must be addressed. And there are smaller slugs that make up the destructive arsenal. Hopefully other more destructive slugs may not supplant them in the foreseeable future. Presently, slug baits and liquid slug sprays seem to be the only deterrent available against these slugs as natural parasites are ineffective.

Natives also cannot escape the ravages of bacterial and fungal infestations. Their destructive presence appear from the seed state to the flowering states where bud drops or flower wilt exact their toll. At times, they accelerate fruit as well as seed rots. Leaf and root rots negate overall plant growth. Fungicides and bactericides sometimes must be utilized to neutralize the effect of rots. Without going into the specifics, some guidelines are suggested. If one must use these chemicals, they should be used sparingly and its usage generally limited as a deterrent. As a deterrents, often a spray of mild solutions of ordinary household detergent of soap water might suffice.

Fungicides and pesticides are available in a powdered or a liquid form. Liquid types generally are not recommended unless specifically advertised as being extremely mild. Usually the chemical nature of the pesticide is not deleterious. Quite often their solvents, such as xylol, has a tendency to "Burn" tender leaves of the natives. Organo-phosphates should be avoided; often spraying these chemicals during warm, sunny days may prove quite lethal. Powdered forms of these chemicals provide the least amount of side effects.

Cultivating our natives above 300 m (1000 feet) elevation usually does not pose much of a problem unless the terrain is unusually wet. Plants growing naturally in extremely wet habitats do not adapt well to drier, lowland culture. For urban culture, plants growing up to 1200 m (4000 feet) elevation generally can be adapted to urban culture with few families resisting general lowland culture in its entirety. Generally under greenhouse cultivation in lowland setting, most species may be pot cultured if night temperatures can be reduced by 6°C (20°F).

Seed germination procedures have been proposed from time to time by various investigators. They range from soaking seeds in water for extended periods, a "hot" water soaking for short periods, or in a chemical bath (e.g., 10% sodium hypochlorite—Chlorox®). Their primary purpose is to soften the tough seed coat so that the embryo can emerge though the protective seed coat. Some simply scarify the seed coat (nicking the seed coat) to facilitate water absorption and emergence of the embryo for germination. Success rates vary in these procedures, but generally success rates are more in tune with the viability of the seeds. At least these procedures seem to accelerate germination rates.

Presently there needs to be standardized basic growing procedures. In so doing, we may be able to isolate and try to correct problem areas. Or perhaps we will be able to recognize problem areas in a systematic way. For example, when one successful method from the previous year results in failure the following year, this may not be the result of technique, but perhaps a biological factor that might be peculiar to the species. We have speculated enough about these problems. Unfortunately, much of the speculations have emanated from some of the academic sources which have not been involved in any viable investigations. Perhaps it is time for these academics to lead the renaissance of effectively cultivating our native flora. One notes that rhetoric often stagnates viable information.

It seems like a travesty to surround visitors to Hawaii's lush, alien, tropical flora grown to cultural perfection while we struggle to show some semblance of our native flora in our general human environment. It would be such an impressive commentary if our urban environment began to reflect some of the true beauty of our native Hawaiian flora.

In the next segment, individual problems and cultural practices of most of the presently cultivated natives will be discussed.

Rubus discolor (Himalayan Blackberry) at Ma'umae Trail, O'ahu, Hawai'i

Christina Crooker
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Established sometime before 1933, *Rubus discolor* Weihe & Nees (Himalayan blackberry) is a relatively new introduction to Hawai'i (Kjargaard 1994),. *Rubus discolor* is native to Eurasia and is currently me before 1983 *Rubus discolor* is currently restricted to the islands of Maui and O'ahu (Wagner *et al.* 1990). Specimens tentatively identified as *Rubus discolor* have been collected from Kaulalewelewe near the trail head to Pu'ukukui, West Maui and from Ma'umae trail and Palolo Valley, O'ahu (Wagner *et al.* 1990; Fred Kraus, personal communication 1998). To date, *Rubus discolor* is the only species of blackberry occurring in the Ko'olau Mountains. This paper will discuss efforts to control the *Rubus discolor* population from Ma'umae trail on O'ahu.

Rubus discolor is a perennial bramble with sturdy 5-angled stems that are 5-15mm in diameter. When young, the stems are somewhat glaucous and sparsely pilose (Wagner *et al.* 1990). Its stems are armed with numerous prickles which are wider at the base and generally curved (Bureau of Land Management, website 1998). Leaves are compound and divided into 3-5 separate leaflets. The leaf margins of *Rubus discolor* are serrate and the leaves are white on the underside. The longest leaf blade measures approximately 5-11 cm. Linear bracts are found at the base of each leaf. The obovate flower petals are white to pinkish and measure 10-15 mm long. Its oblong, aggregate fruits consist of fleshy drupelets that are black when mature (Bureau of Land Management, website 1999).

Rubus discolor aggressively displaces native vegetation in parts of North America ranging from California to British Columbia (Bureau of Land Management, website 1998). Himalayan blackberry is such a serious pest that it has been assigned to List A-1, "Most Invasive Wildland Pest Plants; Widespread", by the California Exotic Plant Pest Council (website 1996). *Rubus discolor* is invasive in riparian areas, marshes, and oak woodlands in California. In riparian areas, it rapidly overtops understory vegetation and spreads by long runners that root at the ends. It is also described as invasive in disturbed moist areas below 5400 feet (1600m) and low, open, and ruderal plant communities such as grasslands, along fence lines, ditches, reservoirs, and road corridors throughout the West coast (Bureau of Land Management, website 1998). The National Park Service reports that it forms thick, impenetrable patches wherever it grows and can expand by 10 feet or more a year. The canes create large, stiff arches that can reach 10 feet or more before bending over and rooting. The only limiting factor reported is its inability to survive in dense shade (National Park Service, website 1998).

Information regarding the dispersal of *Rubus discolor* is limited, yet other *Rubus* species are known to be dispersed by birds. Kjargaard found that in Volcano, Hawai'i, *Zosterops japonicus* (Japanese white eye) readily feed on *Rubus*

ellipticus and to a lesser extent on *Rubus glaucus* (1994). Japanese white eye is the most widespread introduced bird species in the Hawaiian islands (Kjargaard 1994) and is common in the vicinity of the Ma'umae population. Thus, it is probable that *Rubus discolor* is ingested and dispersed by birds, but the extent of such dispersal cannot be estimated at this time.

Although its range is currently limited in Hawai'i, the spread of *Rubus discolor* remains cause for concern. In a study by Kjargaard, shrubs dispersed by ingestion were found to have establishment times ranging from roughly 15 to 60 years. Vines dispersed by ingestion were found become established in roughly 25 to 104 years (1994). Thus, the fact that *Rubus discolor* is not yet widely established may be due to its recent introduction only 16 years ago, rather than being indicative of a benign nature. This implication, combined with the documented invasion of *Rubus discolor* in western North America, and the genus' history as invasive in Hawai'i, presents an ominous picture for native plant communities.

Only two species of *Rubus* can claim Hawai'i as home: *Rubus hawaiiensis* ('akala) from Kaua'i, Moloka'i, Maui, and Hawai'i, and *Rubus macraei*, a rare species from East Maui and Hawai'i. All other species of *Rubus* in the islands are introduced and are invasive to varying degrees. *Rubus argutus* (prickly Florida blackberry) is a serious weed that has naturalized in a variety of habitats on Kaua'i, Maui, Hawai'i, and the Wai'anae mountains of O'ahu. Other introduced species include: *Rubus ellipticus* (yellow Himalayan raspberry), which is established in the Volcano region of Hawai'i; *Rubus niveus* (Hill or mysore raspberry) from Kula, Maui and Volcano, Hawai'i; *Rubus rosifolius* (thimbleberry) which occurs on all the main Hawaiian islands; *Rubus sieboldii* (no common name) from Lawa'i and Kilauea, Kaua'i; and *Rubus glaucous* (no common name) from Puna, Hawai'i (Wagner *et al.* 1994).

Control Efforts

Mechanical control has not been found effective in treating *Rubus discolor* in Hawai'i due to the plants' tendency to resprout from roots remaining in the soil. Chemical methods currently provide the most effective means of controlling blackberry infestations and several herbicide formulations and applications are used in Hawai'i.

At Hawaii Volcanoes National Park, Greg Santos, Linda Cuddihy, and Charles P. Stone tested the effectiveness of 50% Garlon 3A in water, 50% Garlon 4 in diesel, 60% Escort in water, 50% Crossbow in diesel, 50% Arsenal in water, and 20% Tordon 22K in water on *Rubus ellipticus* using a cut stump application. They found that a 50% concentration of Garlon 3A and a 50% concentration of Garlon 4 in diesel were the most effective, killing 95% of yellow Himalayan raspberry stumps (1991).

Also at Hawai'i Volcanoes National Park, Chris Zimmer and Tim Tunison found that a 0.5% foliar application of Garlon 3A in water (no surfactant) was highly effective in controlling *Rubus argutus*. This technique minimized damage to native plants in the area and reduced resprouting (Tim Tunison, personal communication 1998). Greg Santos and Linda Pratt found that a 2% foliar application of Roundup was somewhat less effective and resulted in more adverse impacts on native plants. Dave Smith reports that undiluted Rodeo applied to cut rooted canes was effective for control and that canes cut into one foot segments did not resprout in an area receiving 100 inches of rain per year (Secretariat for Conservation Biology 1997). Talbert Takahama of the O'ahu Natural Area Reserve System uses Rodeo on cut stems of *Rubus argutus* at Mt. Ka'ala because Rodeo is safe for use in wetlands. When wetlands are not a concern, Takahama recommends using undiluted Garlon 3A on cut stems (Fred Kraus, personal communication 1998).

In Koke'e State Park, Kate Reinard uses a cut stump application of 15-20% Garlon 4 in diesel to control *Rubus argutus* (Kerri Fay, personal communication 1999).

Pat Biley from The Nature Conservancy of Hawai'i uses a basal treatment of Garlon 4 in diesel for populations of *Rubus discolor* on Maui, reporting 95% mortality in treated canes. Biley also suggests using 0.5% to 2% Garlon 3A with a surfactant such as Silguard, Breakthrough, or Pulse. This method may result in less translocation and require the use of more personal protective equipment than the basal bark treatment (Pat Biley, personal communication 1998).

Biological control has been undertaken for only one *Rubus* species, *Rubus argutus*. The Hawai'i Department of Agriculture has released five insect biological control agents for this pest.

The blackberry skeletonizer, *Schreckensteinia festaliella*, was introduced from California in 1963. This heliodinid moth is established on Hawai'i, Maui, and Kaua'i. After recent releases, it is now established on Mt Ka'ala, O'ahu. Although feeding damage to terminal shoots is very noticeable in some localities, prickly Florida blackberry continues to outgrow the damage because soil moisture is always adequate in the habitat where it grows. A tortrioid moth, *Croesia zimmermani*, was introduced from Mexico in 1963. This species is established on Hawai'i, Maui, and Kaua'i. Typically, it is a leaf eater and has caused extensive damage to terminal shoots. However, as with the blackberry skeletonizer, the vigorous growth of blackberry overcomes foliar damage. An aegerid moth, *Bembecia marginata*, was introduced from Oregon in 1963, but failed to become established. The blackberry sawfly, *Priophorus morio*, was introduced from Oregon in 1966. This tenthredinid is established on Kaua'i and O'ahu (Mt. Ka'ala), but population densities are very low and damage to blackberry is negligible. A chrysomelid beetle, *Chlamisus gibbosa* was introduced from Missouri in 1967 and 1968, but never became established (Myron Isherwood, personal communication 1998). All five agents are now considered ineffective (Santos *et al.* 1991). Don Gardner found a fairly effective blackberry rust, but terminated his research when he found that it also attacked native *Rubus* species (Secretariat for Conservation Biology 1991)

Site Descriptions

The O'ahu population of *Rubus discolor* is located about 1 mile toward the Ko'olau summit from the Ma'umae Trail (formerly Lanipo Trail) head and is immediately adjacent to the trail. The bulk of the population occurs on Kamehameha Schools/Bishop Estate property on the east-facing slope, though some plants were observed on the steep west-facing slope on City and County of Honolulu property. On Bishop Estate land, the population is naturally bounded by dense strawberry guava (*Psidium cattleianum*) and on the south by a stand of ironwood (*Casuarina equisetifolia*). The plants thin out toward the north, though no natural boundaries exist. Due to time constraints, the extent of the population toward the north was not determined. A much smaller subpopulation has been sighted near Palolo Stream, directly down slope and westward from the Ma'umae population (Fred Kraus, personal communication 1998). It is likely additional plants may be found on the steep slopes between Ma'umae trail and Palolo valley below. The plants were observed in flower and fruit in May and were primarily vegetative in October and December.

The vegetation at the site is a disturbed lowland mesic forest dominated by introduced species with scattered natives throughout. It has been suggested that the site was previously burned and that the population appears to have been intentionally planted (Wagner *et al.* 1990). The vegetation seems consistent with a prior burn because introduced grasses as well as native fern species that tend to colonize barren areas dominate the site. The most dominant species are the introduced grass *Andropogon virginicus* (broomsedge) and the indigenous fern, *Odontosoria chinensis* (pala'a). A dense understory of *Dicranopteris linearis* (uluhe) fern is found near the perimeter of the population and thins out where blackberry is most common. Other species commonly found in the area are *Stachytarpheta dichotoma* (oi), *Ardisia crenata* (Hilo holly), *Clusea rosea* (autograph tree), *Setaria palmifolia* (palm grass), *Melinus minutiflora* (molasses grass), *Lantana camara* (lantana), *Clidemia hirta* (Koster's curse), *Psidium guajava* (common guava) and *Schinus terebinthefolius* (Christmas berry). Native species are scattered and include *Metrosideros polymorpha* ('ohi'a), *Acacia koa* (koa), *Santalum freycinetianum* ('iliahi), *Psydrax odoratum* (alahe'e), *Ilex anomala (kawa'u)*, *Syzygium sandwicensis* ('ohi'a ha), and *Diospyros sandwicensis* (lama).

Course of Action

In order to determine the most effective and easiest means of controlling *Rubus discolor*, ten different herbicide treatments were tested. The treatments used combinations of herbicide (Garlon 3A and Garlon 4), application method (foliar, basal bark, and cut stump), and concentration (ranging from 0.5% for foliar to 100% for cut stump). The results of such treatments are pending but it appears that most treatments kill 95 - 100 % of the above-ground canes. The underground rhizome, which is able to resprout, is not typically killed on the first application. However, repeated treatments

every six months to one year should kill the entire plant (Biley, personal communication 1999).

The Fountain Grass Working Group, founded in 1998, has begun to address the problem of incipient weed species on O'ahu and is working to control *Rubus discolor*. The Fountain Grass Working Group is a voluntary partnership of private, government and non-profit organizations to remove the threat of Fountain grass on O'ahu and to assess the status of and prioritize control efforts for additional invasive species on O'ahu. Members donate supplies and volunteer time to control target weed species. Kamehameha Schools Bishop Estate has generously granted permission to control this pest plant on their property.

Although *Rubus discolor* is not yet widely established in Hawai'i, the combined factors of its invasion in western North America, its probable dispersal by birds, its vigorous vegetative spread, and the history of the genus' invasion in Hawai'i make *Rubus discolor* a high priority for control and eradication. Efforts to control this species should be intensified while the Ma'umae population is still incipient in order to prevent Himalayan blackberry from spreading throughout the Ko'olau Mountains and displacing some of the most pristine natural communities on O'ahu.

Several work trips to control *Rubus discolor* will be organized this summer. **Volunteers are needed!** See notice below for contact information.

ACKNOWLEDGEMENTS

Thank you to the members of the Fountain Grass Working Group and the many other friends, co-workers, family members and significant others who have volunteered in support of this project so far. You are much appreciated!

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VOLUNTEERS NEEDED!

Anyone interested in volunteering to help control Himalayan blackberry should contact Christina Crooker at 541-3441. Those interested in voluteering to work on related projects of the Fountain Grass Working Group should contact Jordan Jokiel at 656-6741.

Treasurer's Report
January to December 1998

Ron Fenstemacher, Treasurer

Once again, due to diligent fundraising efforts and benevolent member donations, the Society finished the year in the black, with about eight hundred dollars surplus in the annual fund. This good news is moderated by several considerations though, only half of 1998's pre-grad grant was spent, only half an annual payment to the Life Member Fund (LMF) was made, and only two issues of the newsletter were shipped. Thus, 1998 was a qualified success for the Society's annual fund. On the other hand, the LMF ended the year ahead about two thousand dollars, roughly a thousand dollars short of its goal, a swell year for the LMF. So, while the customary caveat still applies about revenue adjustments Newsletter gathers steam, 1998 was yet another good year for the Society.

The Treasurer would like to recognize Vickie Caraway for her thorough financial audit of the Society's books for 1997. Maholo nui loa!

1998 Annual Fund Summary:

Income		**Outgo**	
Annual Dues	$1916.00	Copying	$787.46
Garage Sale	$492.55	Postage	$522.33
Pre-Grad Grant	$435.71	97 Life Dues (2)	$360.00
Donations	$166.00	1/2 Annual Payment	$250.00
Plant Raffle	$70.00	Science Fair	$241.80
Newsletter Copies	$70.00	Pre-Grad Grant	$223.49
Interest	$64.29	Miscellaneous	$31.25
Earth Day	$34.00	Earth Day	$25.00
		Bank Fees	$12.50
Total Income	$3248.55		
		Total Outgo	$2453.83

Beginning Balance	+	Income	—	Outgo	=	Ending Balance
$3484.39	+	$3248.55	—	$2453.83	=	$4279.11

The net gain for the annual fund in 1998 is $794.72

1998 Annual Dues Received Summary:

Student	18 × 1 yr	$90.00
Individual	114 × 1 yr	$1140.00
	4 × 2 yr	$80.00
	2 × 3 yr	$60.00
	1 × 4 yr	$40.00
Family	23 × 1 yr	$276.00
Institutional	11 × 1 yr	$220.00
Obsolete Rates	1 × 1 yr	$10.00
Annual Dues Total		$1916.00

Life Membership Fund Summary:

Income		Outgo	
Donation	$1000.00		
97 Life Dues	360.00	Neal-Miller Fund Reimburse	$150.00
1/2 Annual Payment	250.00		
Interest	$225.36	Total Outgo	$150.00
Total Income	$1835.36		

Beginning Balance	+	Income	—	Outgo	=	Ending Balance
$3179.67	+	$1835.36	—	$150.00	=	$4865.03

The mid-December balance above reflects the amount in the LMF certificate of deposit at its mid-December maturity. The New Year's Eve balance would include both 1998 life memberships ($360.00) and a donation ($150.00), for a final total of $5375.03. The addition of two new life members in 1998, with no looses thank heaven, increases the LMF target sum to $6660.00. The LMF is short this final goal by $1284.97.

Respectfully Submitted,

Ron Fenstemacher

Ron Fenstemacher, Treasurer

January 29, 1999

Hawaiian Botanical Society
3190 Maile Way
c/o Botany Department
Honolulu, HI 96822

Re: Accounts audit

Dear Society:

I have reviewed the account books and the treasurer's report for the Hawaiian Botanical Society for the calendar year 1998. The books and the reports were found to be detailed and accurate, with no discrepancies noted in the disbursements.

I would like to add that the knowledge and enthusiasm of the current treasurer, Ron Fenstemacher, serves our Society well. I wish him a long tenure as our treasurer.

Sincerely,

K. Bartlett Durand, Jr.
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Honolulu, Hawaii 96821
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